STATUS OF CLAIMS

Claims 1-9 are currently pending in this application.

Claims 1and 6 have been amended. No new matter has been introduced into the application by these amendments.

REMARKS

Reconsideration of this application is requested in view of the following remarks and accompanying amendments.

Claim rejections 35 USC § 112

Claim 6 stands rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Specifically, the term "thick" in claim 6 has been rejected for being "a relative term which renders the claim indefinite". By way of this response, claim 6 has been amended to replace the phrase "a thick titanium layer" with "a titanium layer thicker than 10 nm". Support for this amendment may be found, for example, in paragraphs [0026], [0035] and [0037] of the specification as published, each stating that a "thick" titanium layer has a "thickness greater than from 10 to 20 nm".

Withdrawal of the 35 U.S.C. § 112, second paragraph, rejection of claim 6 is respectfully requested.

Claim Rejections - 35 U.S.C. § 103

Claims 1-9 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Jang (Metallic conductivity in bamboo-shaped multiwalled carbon nanotubes) in view of Marty (Batch processing of nanometer-scale electrical circuitry based on in-situ grown single-walled carbon nanotubes). Applicant respectfully traverses this rejection over the prior art of record for at least the following reasons.

Independent claim 1 is directed to a method of growing carbon nanotubes and recites:

> A method for growing carbon nanotubes on a substrate by a hot-filament assisted chemical vapor deposition method, comprising the step of depositing on the substrate a titanium and cobalt bilayer such that:
> the thickness of the titanium layer ranges between 0.5 and 5 nm;
> the thickness of the cobalt layer ranges between 0.25 and 10 nm; and
> the thickness of the cobalt layer ranges between half and twice the thickness of the titanium layer (emphasis added).

Claim 1 is direct to a method of growing carbon nanotubes on structures by a hot filament assisted chemical vapor disposition (CVD) method. The resulting structures are represented in Figs. 2A and 2B (reproduced below). Claim 1 requires the thickness of the Ti layer to range between 0.5 and 5 nm and the thickness of the Co layer to range between 0.25 and 10 nm. The Co layer may be above the Ti layer (Fig. 2A), or the Ti layer may be above the Co layer (Fig. 2B).

An unexpected advantage of the claimed structure is that, with a hot filament assisted CVD method, growth of carbon nanotubes on both the lateral surfaces of the Co/Ti bilayer and on the upper surface of the bilayer may be achieved. See Figs. 2A and 2B and paragraph [0028] of the specification as published. The Action cites the combination of Jang and Marty as making obvious this arrangement.

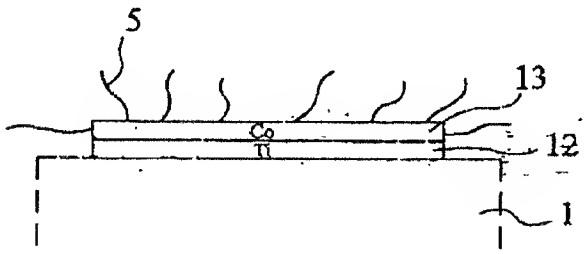


Fig 2A

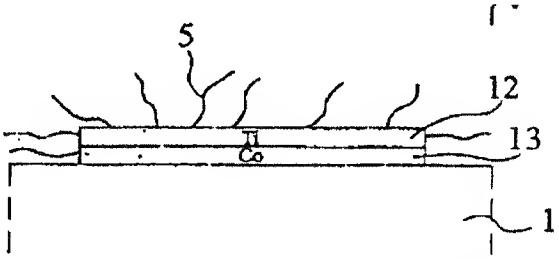
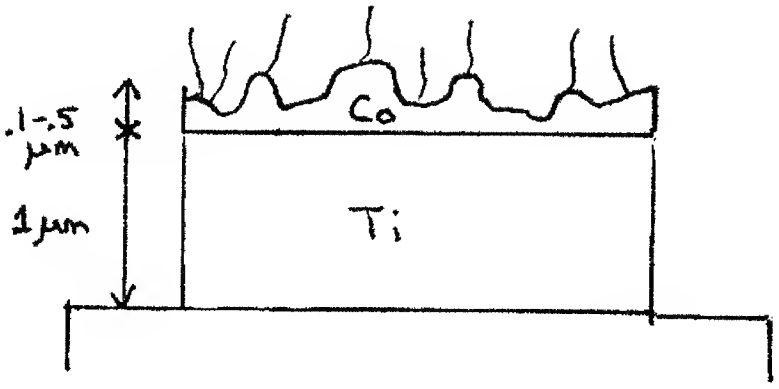


Fig 2B

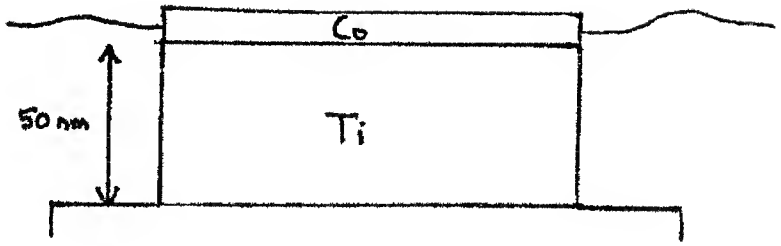
As acknowledged by the Examiner in item 9 of the Office Action, neither Jang nor Marty disclose the thicknesses of the Co and Ti layers set forth in claim 1 (and claim 8). Furthermore, neither Jang nor Marty suggest altering their Co and Ti layers to a thickness even remotely relating to the claimed dimensions. As these references wholly fail to teach the claimed arrangement, the combination of these references would not achieve the unique and unexpected growth on both the lateral and upper surfaces of the bilayer as discovered by the Applicant. For example, Jang uses a structure schematically represented hereunder:



In Jang, a Co layer is deposited on a Ti layer of 1 μm in thickness (see page 619, column 2, last line). The Ti layer is thus at least 200 times thicker than that set forth in claim 1 (1 μm instead of 0.5-5 nm). From Fig.3(II)(a) of Jang, it is shown that the thickness of the Co layer is between 0.1 and 0.5 μm. Thus, Jang's Co layer is at least 10 times thicker than that recited in claim 1. Fig.3(II)(a) also shows that the surface roughness of the Co layer is high, as schematically represented in the above figure.

Fig. 1(a) of Jang shows that the carbon nanotubes are growing on the upper surface of the Co layer and are vertically well-aligned, as schematically represented in the above figure. In Jang, the carbon nanotubes do not also grow laterally as achieved through embodiments of the present invention.

While the carbon nanotubes of Jang are grown with a thermal CVD method (see page 619, column 1, last line), and not with a hot filament assisted CVD method as required by claim 1, Marty uses a hot filament assisted CVD method for growing carbon nanotubes. A structure according to the teachings of Marty is schematically represented hereunder:



In Marty, a Co layer is deposited on a Ti layer (see page 486, item 2). The thickness of the Ti layer, however, is 50 nm. Thus this Ti layer is 10 to 100 times thicker than that of claim 1. The thickness of the Co layer is not indicated. With a Ti layer of 50 nm in thickness and with a hot filament assisted CVD method, the carbon nanotubes grow from the lateral surfaces of the Co layer, as set forth in the prior art description of the present application (see paragraph [0025]) and as shown schematically in Fig. 1. The same result is obtained by Marty, as shown in Fig. 1(a) and (b), and as schematically represented in the above figure.

Regarding the claimed thicknesses, the Action goes on to state:

> ...Jang teaches the size and type (Co) of catalyst layer is proportional to nanotubes growth and therefore a result effective variable. Therefore, it would have been obvious to one or ordinary skill in the art at the time of the invention to provide the claimed thicknesses, proportional to Marty, and optimize the result effective variable to control diameter (size) and growth rate of the nanotubes in order to provide advantageous properties such as good electrical contact and degree of control and adhesion of the nanotubes to the metal contact during growth...(emphasis added)

Applicant traverses the Examiner's assertion. MPEP Section 2144.05 sets forth guidelines for rejections based on ranges of values. Regarding rejections based on result-effective variables (in this instance, dimensions), a particular parameter

must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation. *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977) (The claimed wastewater treatment device had a tank volume to contractor area of 0.12 gal./sq. ft. The prior art did not recognize that treatment capacity is a function of the tank volume to contractor ratio, and therefore the parameter optimized was not recognized in the art to be a result-effective variable.). See also *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980) (prior art suggested proportional balancing to achieve desired results in the formation of an alloy).

Nowhere does Jang or Marty suggest (i.e. show recognition) that the relative thicknesses of either or both the layers may provide for simultaneous nanotube growth on both the lateral surfaces and the upper surface of the structure. Jang merely teaches that altering the size and type of the Co layer (only) affects the size and rate of tube growth. See Jang, item 2. Thus, forming a structure based on Jang in combination with Marty, using the claimed dimensions, goes well beyond merely optimizing to achieve a known recognized result, as growth on both sides of these structures was not recognized (i.e. was not a recognized result) as a function of the thicknesses of either or both of the respective layers.

Further, the references specifically teach, and the Action repeats, that it is the Co catalyst layer which alters tube growth, and makes no mention of the thickness of the Ti layer and/or the relative thicknesses of the Ti and Co layers affecting growth

on various sides of the structure. Thus, the thickness of the Ti layer, and/or the relative relationship of the thickness of the Ti layer to the Co layer is not a recognized parameter or variable.

For at least the reason that simultaneously growing nanotubes on both the lateral and upper walls of a structure is not a recognized result of altering the dimensions of the Co and/or Ti layer, and thus, that altering the Ti layer is not a recognized parameter for achieving this result, claim 1 is not obvious in view of the prior art and should be allowed.

Moreover, in *Gardner v. TEC Systems, Inc.*, 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), *cert. denied*, 469 U.S. 830, 225 USPQ 232 (1984), the Federal Circuit held that, where the only difference between the prior art and the claims was a recitation of relative dimensions of the claimed device and a device having the claimed relative dimensions would not perform differently than the prior art device, the claimed device was not patentably distinct from the prior art device.

In distinction, the arrangements of both Jang and Marty would indeed perform differently having the claimed dimensions. Specifically, the opportunity for growth on both the lateral surfaces and the upper surface may be realized by incorporating the unique claimed arrangement. Again, these are properties not taught, or even remotely contemplated by Jang or Marty.

Thus, those skilled in the art, knowing Marty and wishing to obtain a growth of nanotubes also from the upper surface of the structure, by the hot filament assisted

CVD method, could not find in Jang any teaching for arriving to the claimed innovative solution, i.e. reducing the thickness of the Ti layer.

Claim 8 recites limitations similar to those set forth above with respect to claim 1, and should be allowable for at least the same reasons. Claims 2-7 and 9 should be patentable at least by virtue of these claims' ultimate dependence from claims 1 and 8.

Further, claim 2 requires that "the titanium layer is formed on the cobalt layer." See, for example, Applicant's Fig. 2B. The Action is silent as to where Jang or Marty disclose this arrangement. As set forth in their respective specifications (see item 2 "Experiments" of Jang and item 2 "Device fabrication" of Marty), as well as in the representative figures above, both Marty and Jang utilize a cobalt catalyst applied on a titanium layer, rather than the reverse arrangement set forth in claim 2. For at least this reason, claim 2 should be allowable.

Claims 4 and 9 each require the presence of at least one tip (microtip) formed by the substrate. See, for example, Fig. 3 of Applicant's specification. While the Action addresses claims 4 and 9, it does so only with regard to the growth process of "spreading", and is completely silent as to where either Jang or Marty disclose a substrate having a tip, or the nanotubes growth with respect therefrom. Accordingly, as neither Jang nor Marty teach the claimed structure, claims 4 and 9 should be allowable.

In view of the foregoing, reconsideration and withdrawal of the 35 U.S.C. § 103(a) rejection of claims 1-9 is respectfully requested.

It is believed that all of the pending claims have been addressed. However, the absence of a reply to a specific rejection, issue or comment does not signify agreement with or concession of that rejection, issue or comment. In addition, because the arguments made above may not be exhaustive, there may be reasons for patentability of any or all pending claims (or other claims) that have not been expressed. Finally, nothing in this paper should be construed as an intent to concede any issue with regard to any claim, except as specifically stated in this paper, and the amendment of any claim does not necessarily signify concession of unpatentability of the claim prior to its amendment.

CONCLUSION

Applicant believes he has addressed all outstanding grounds raised by the Examiner and respectfully submits the present case is in condition for allowance, early notification of which is earnestly solicited.

Should there be any questions or outstanding matters, the Examiner is cordially invited and requested to contact Applicant's undersigned attorney at his number listed below.

Respectfully submitted,

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